

WHAT IS CLAIMED IS:

1 1. A method comprising:
2 observing a finite duration signal y_n that comprises
3 a representation of a mixture of a desired signal and an
4 undesired signal, the undesired signal comprising an offset
5 component;
6 modeling the offset component of the undesired
7 signal as comprising a step function u defined by unknown step
8 function parameters;
9 estimating the unknown step function parameters; and
10 adjusting y_n based on the estimated step function
11 parameters.

1 2. The method of claim 1 in which y_n comprises a
2 continuous signal.

1 3. The method of claim 1 in which y_n comprises a
2 discrete signal.

1 4. The method of claim 3 in which:
2 y_n includes N samples and comprises a discrete
3 representation of a mixture of the desired signal, the
4 undesired signal, and a second signal including a generally

5 sinusoidal waveform and an attenuated version of the desired
6 signal; and

7 y_n is modeled as including a discrete representation
8 of the desired signal and a discrete representation of an
9 offset component related to a square of the undesired signal,
10 in which the offset component is modeled as comprising a step
11 function u defined by unknown step function parameters.

1 5. The method of claim 1 in which the step function
2 parameters include a first parameter c_1 indicative of a first
3 amplitude of the step function, a second parameter c_2
4 indicative of a second amplitude of the step function, and a
5 third parameter α indicative of a point at which the step
6 function transitions from the first amplitude to the second
7 amplitude, and in which the desired signal is a function of at
8 least one unknown signal parameter θ .

1 6. The method of claim 5 in which y_n includes N
2 samples and estimating the step function parameters includes
3 jointly estimating θ , c_1 , c_2 , and α ($0 \leq \alpha < N$) based on a non-
4 linear optimization method.

1 7. The method of claim 5 in which y_n includes N
2 samples and estimating the step function parameters includes

3 estimating c_1 , c_2 , and α ($0 \leq \alpha < N$) based on a maximum
 4 likelihood method.

1 8. The method of claim 7 in which the estimates of
 2 the step function parameters comprise:

3 a first estimate \hat{c}_1 of c_1 where

$$4 \quad \hat{c}_1 \approx \frac{1}{\hat{\alpha}} \sum_{n=0}^{\hat{\alpha}-1} y_n ;$$

5 a second estimate \hat{c}_2 of c_2 where

$$6 \quad \hat{c}_2 \approx \frac{1}{N - \hat{\alpha}} \sum_{n=\hat{\alpha}}^{N-1} y_n ; \text{ and}$$

7 a third estimate $\hat{\alpha}$ of α where

$$8 \quad \hat{\alpha} \approx \arg \max_{\alpha_{Test}} \frac{1}{\alpha_{Test}} \left| \sum_{n=0}^{\alpha_{Test}-1} y_n \right|^2 + \frac{1}{N - \alpha_{Test}} \left| \sum_{n=\alpha_{Test}}^{N-1} y_n \right|^2, \quad 0 \leq \alpha_{Test} < N-1.$$

1 9. The method of claim 8 in which determining $\hat{\alpha}$
 2 comprises:

3 selecting more than one value of α_{Test} ;

4 determining a value g for each selected value of
 5 α_{Test} where

$$6 \quad g \approx \frac{1}{\alpha_{Test}} \left| \sum_{n=0}^{\alpha_{Test}-1} y_n \right|^2 + \frac{1}{N - \alpha_{Test}} \left| \sum_{n=\alpha_{Test}}^{N-1} y_n \right|^2 ;$$

7 selecting from among the determined values of g one
 8 or more maximum values of g ; and

9 selecting $\hat{\alpha}$ based on the one or more maximum values
10 of g .

1 10. The method of claim 9 in which less than N
2 values of α_{Test} are selected.

1 11. The method of claim 7 in which estimating the
2 step function parameters further comprises jointly estimating
3 θ , $c1$, $c2$, and α based on a non-linear minimization of a
4 function comprising

$$f(\theta, c1, c2, \alpha) \approx \sum_{n=0}^{\alpha-1} \left| y_n - \frac{1}{\alpha} \sum_{m=0}^{\alpha-1} y_m - \frac{A_0}{2} s_m(\theta) + \frac{1}{\alpha} \sum_{m=0}^{\alpha-1} \frac{A_0}{2} s_m(\theta) \right|^2$$
$$+ \sum_{n=\alpha}^{N-1} \left| y_n - \frac{1}{N-\alpha} \sum_{m=\alpha}^{N-\alpha} y_m - \frac{A_0}{2} s_n(\theta) + \frac{1}{N-\alpha} \sum_{m=\alpha}^{N-\alpha} \frac{A_0}{2} s_m(\theta) \right|^2$$

6 in which the minimization is performed by computing
7 one or more of the derivatives of f .

1 12. A system comprising:
2 an observation circuit structured and arranged to
3 observe a finite duration signal y_n that comprises a discrete
4 representation of a mixture of a desired signal and an
5 undesired signal, the undesired signal comprising an offset
6 component;

7 a modeling circuit structured and arranged to model
8 the offset component of the undesired signal as comprising a
9 step function u defined by unknown step function parameters;
10 an estimating circuit structured and arranged to
11 determine estimated step function parameters representative of
12 the unknown step function parameters; and
13 a correction circuit structured and arranged to
14 correct y_n based on the estimated step function parameters.

1 13. The system of claim 12 in which y_n comprises a
2 continuous signal.

1 14. The system of claim 12 in which y_n comprises a
2 discrete signal.

1 15. The system of claim 14 in which:
2 y_n includes N samples and comprises a discrete
3 representation of a mixture of the desired signal, the
4 undesired signal, and a second signal including a generally
5 sinusoidal waveform and an attenuated version of the desired
6 signal; and
7 the modeling circuit is further configured to model
8 y_n as comprising a discrete representation of the desired

9 signal and also a discrete representation of an offset
10 component related to a square of the undesired signal.

1 16. The system of claim 12 in which the unknown
2 step function parameters include a first parameter c_1
3 indicative of a first amplitude of the step function, a second
4 parameter c_2 indicative of a second amplitude of the step
5 function, and a third parameter α indicative of a point at
6 which the step function transitions from the first amplitude
7 to the second amplitude, and in which the desired signal is a
8 function of at least one unknown signal parameter θ .

1 17. The system of claim 16 in which y_n includes N
2 samples and the estimating circuit is further configured to
3 estimate jointly the unknown step function parameters θ , c_1 ,
4 c_2 , and α ($0 \leq \alpha < N$) based on a non-linear optimization method.

1 18. The system of claim 16 in which y_n includes N
2 samples and the estimating circuit is further configured to
3 estimate the unknown step function parameters c_1 , c_2 , and α
4 ($0 \leq \alpha < N$) based on a maximum likelihood method.

1 19. The system of claim 18 in which the estimating
2 circuit is further configured to estimate the unknown step
3 function parameters as comprising:

4 a first estimate $\hat{c}1$ of $c1$ where

$$5 \quad \hat{c}1 \approx \frac{1}{\hat{\alpha}} \sum_{n=0}^{\hat{\alpha}-1} y_n ;$$

6 a second estimate $\hat{c}2$ of $c2$ where

$$7 \quad \hat{c}2 \approx \frac{1}{N - \hat{\alpha}} \sum_{n=\hat{\alpha}}^{N-1} y_n ; \text{ and}$$

8 a third estimate $\hat{\alpha}$ of α where

$$9 \quad \hat{\alpha} \approx \arg \max_{\alpha_{Test}} \frac{1}{\alpha_{Test}} \left| \sum_{n=0}^{\alpha_{Test}-1} y_n \right|^2 + \frac{1}{N - \alpha_{Test}} \left| \sum_{n=\alpha_{Test}}^{N-1} y_n \right|^2, \quad 0 \leq \alpha_{Test} < N .$$

1 20. The system of claim 19 in which the estimating
2 circuit is further configured to determine $\hat{\alpha}$ based on the
3 following:

4 selecting more than one value of α_{Test} ;

5 determining a value g for each selected value of

6 α_{Test} where

$$7 \quad g \approx \frac{1}{\alpha_{Test}} \left| \sum_{n=0}^{\alpha_{Test}-1} y_n \right|^2 + \frac{1}{N - \alpha_{Test}} \left| \sum_{n=\alpha_{Test}}^{N-1} y_n \right|^2 ;$$

8 selecting from among the determined values of g one
9 or more maximum values of g ; and

10 selecting $\hat{\alpha}$ based on the one or more maximum values
11 of g.

1 21. The system of claim 20 in which less than N
2 values of α_{Test} are selected by the estimating circuit.

1 22. The system of claim 18 in which the estimating
2 circuit is further configured to estimate jointly the unknown
3 step function parameters θ , c1, c2, and α based on non-linear
4 minimization of a function comprising

5

$$f(\theta, c1, c2, \alpha) \approx \sum_{n=0}^{\alpha-1} \left| y_n - \frac{1}{\alpha} \sum_{m=0}^{\alpha-1} y_m - \frac{A_0}{2} s_m(\theta) + \frac{1}{\alpha} \sum_{m=0}^{\alpha-1} \frac{A_0}{2} s_m(\theta) \right|^2$$
$$+ \sum_{n=\alpha}^{N-1} \left| y_n - \frac{1}{N-\alpha} \sum_{m=\alpha}^{N-\alpha} y_m - \frac{A_0}{2} s_n(\theta) + \frac{1}{N-\alpha} \sum_{m=\alpha}^{N-\alpha} \frac{A_0}{2} s_m(\theta) \right|^2$$

6 in which minimization is performed by computing one or more of
7 the derivatives of f.

1 23. A computer program stored on a computer
2 readable medium or a propagated signal, the computer program
3 comprising:
4 an observation code segment configured to cause a
5 computer to observe a finite duration signal y_n that comprises
6 a representation of a mixture of a desired signal and an
7 undesired signal, the undesired signal comprising an offset
8 component;

9 a modeling code segment configured to cause the
10 computer to model the offset component of the undesired signal
11 as comprising a step function u defined by unknown step
12 function parameters;

13 an estimating code segment configured to cause the
14 computer to determine estimated step function parameters
15 representative of the unknown step function parameters; and

16 a correcting code segment configured to cause the
17 computer to correct y_n based on the estimated step function
18 parameters.

1 24. The computer program of claim 23 in which y_n
2 comprises a continuous signal.

1 25. The computer program of claim 23 in which y_n
2 comprises a discrete signal.

1 26. The computer program of claim 25 in which:
2 y_n includes N samples and comprises a discrete
3 representation of a mixture of the desired signal, the
4 undesired signal, and a second signal including a generally
5 sinusoidal waveform and an attenuated version of the desired
6 signal;

7 a modeling code segment configured to cause the
8 computer to model y_n as comprised of s_n , a discrete
9 representation of the desired signal and also a discrete
10 representation of an offset component related to a square of
11 the undesired signal, in which the modeling code segment also
12 is configured to cause the computer to model the offset
13 component as comprising a step function u defined by unknown
14 step function parameters.

1 27. The computer program of claim 23 in which the
2 unknown step function parameters include a first parameter c_1
3 indicative of a first amplitude of the step function, a second
4 parameter c_2 indicative of a second amplitude of the step
5 function, and a third parameter α indicative of a point at
6 which the step function transitions from the first amplitude
7 to the second amplitude, and in which the desired signal is a
8 function of at least one unknown signal parameter θ .

1 28. The computer program of claim 27 in which y_n
2 includes N samples and the estimating code segment further
3 comprises a non-linear optimization code segment configured to
4 cause the computer program to estimate jointly the unknown
5 step function parameters θ , c_1 , c_2 , and α ($0 \leq \alpha < N$) based on a
6 non-linear optimization method.

1 29. The computer program of claim 27 in which y_n
 2 includes N samples and the estimating code segment further
 3 comprises a maximum likelihood code segment configured to
 4 cause the computer to estimate the unknown step function
 5 parameters c_1 , c_2 , and α ($0 \leq \alpha < N$) based on a maximum
 6 likelihood method.

1 30. The computer program of claim 29 in which the
 2 maximum likelihood code segment is further configured to cause
 3 the computer to estimate the unknown step function parameters
 4 as comprising:

5 a first estimate \hat{c}_1 of c_1 where

$$6 \quad \hat{c}_1 \approx \frac{1}{\hat{\alpha}} \sum_{n=0}^{\hat{\alpha}-1} y_n ;$$

7 a second estimate \hat{c}_2 of c_2 where

$$8 \quad \hat{c}_2 \approx \frac{1}{N - \hat{\alpha}} \sum_{n=\hat{\alpha}}^{N-1} y_n ; \text{ and}$$

9 a third estimate $\hat{\alpha}$ of α where

$$10 \quad \hat{\alpha} \approx \arg \max_{\alpha_{Test}} \frac{1}{\alpha_{Test}} \left| \sum_{n=0}^{\alpha_{Test}-1} y_n \right|^2 + \frac{1}{N - \alpha_{Test}} \left| \sum_{n=\alpha_{Test}}^{N-1} y_n \right|^2, \quad 0 \leq \alpha_{Test} < N .$$

4 parameters θ , $c1$, $c2$, and α based on non-linear minimization
 5 of a function comprising

$$f(\theta, c1, c2, \alpha) \approx \sum_{n=0}^{\alpha-1} \left| y_n - \frac{1}{\alpha} \sum_{m=0}^{\alpha-1} y_m - \frac{A_0}{2} s_m(\theta) + \frac{1}{\alpha} \sum_{m=0}^{\alpha-1} \frac{A_0}{2} s_m(\theta) \right|^2$$

$$+ \sum_{n=\alpha}^{N-1} \left| y_n - \frac{1}{N-\alpha} \sum_{m=\alpha}^{N-\alpha} y_m - \frac{A_0}{2} s_n(\theta) + \frac{1}{N-\alpha} \sum_{m=\alpha}^{N-\alpha} \frac{A_0}{2} s_m(\theta) \right|^2$$

7 in which the minimization is performed by computing one or
 8 more of the derivatives of f .

1 34. A processor which:

2 observes a finite duration signal y_n that comprises
 3 a representation of a mixture of a desired signal and an
 4 undesired signal, the undesired signal comprising an offset
 5 component;

6 models the offset component of the undesired signal
 7 as a step function u defined by unknown step function
 8 parameters;

9 determines estimated step function parameters; and

10 corrects the signal y_n based on the estimated step
 11 function parameters.

1 35. The processor of claim 34 in which y_n comprises
 2 a continuous signal.

1 36. The processor of claim 34 in which y_n comprises
2 a discrete signal.

1 37. The processor of claim 36 in which:

2 y_n includes N samples and comprises a discrete
3 representation of a mixture of the desired signal, the
4 undesired signal, and a second signal including a generally
5 sinusoidal waveform and an attenuated version of the desired
6 signal; and

7 y_n is modeled as including a discrete representation
8 of the desired signal and also a discrete representation of an
9 offset component related to a square of the undesired signal,
10 and models the offset component as a step function u defined
11 by unknown step function parameters.

1 38. The processor of claim 34 in which y_n includes
2 N samples and the unknown step function parameters include a
3 first parameter $c1$ indicative of a first amplitude of the step
4 function, a second parameter $c2$ indicative of a second
5 amplitude of the step function, and a third parameter α
6 ($0 \leq \alpha < N$) indicative of a point at which the step function
7 transitions from the first amplitude to the second amplitude.

1 39. The processor of claim 38 in which the
 2 processor estimates the unknown step function parameters as
 3 comprising:

4 a first estimate \hat{c}_1 of c_1 where

5
$$\hat{c}_1 \approx \frac{1}{\hat{\alpha}} \sum_{n=0}^{\hat{\alpha}-1} y_n ;$$

6 a second estimate \hat{c}_2 of c_2 where

7
$$\hat{c}_2 \approx \frac{1}{N - \hat{\alpha}} \sum_{n=\hat{\alpha}}^{N-1} y_n ; \text{ and}$$

8 a third estimate $\hat{\alpha}$ of α where

9
$$\hat{\alpha} \approx \arg \max_{\alpha_{Test}} \frac{1}{\alpha_{Test}} \left| \sum_{n=0}^{\alpha_{Test}-1} y_n \right|^2 + \frac{1}{N - \alpha_{Test}} \left| \sum_{n=\alpha_{Test}}^{N-1} y_n \right|^2 .$$

Tested and approved